

Alien Mollusca along the Calabrian shores of the Messina Strait area and a review of their distribution in the Italian seas

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Abstract

Nine alien molluscan species are reported from the Calabrian shores of the Messina Strait area. Four of them, *Haminoea cyanomarginata*, *Bursatella leachii*, *Melibe viridis* and *Brachidontes pharaonis*, were previously known from the investigated area, even though from scarce findings. The questioned presence of *Syphonota geographica* in the Messina Strait is confirmed, while *Cerithium scabridum*, *Aplysia dactylomela*, *Pinctada radiata* and *Fulvia fragilis* are new records for the area. New sites of presence of *C. scabridum* and *F. fragilis* out of the Strait area are also reported and the distribution in the Italian seas of the nine alien species is reviewed. Some updates in LA CHECKLIST DELLA FAUNA MARINA ITALIANA should be necessary, according to the literature data and the results of the present work.

Riassunto

Approfondite ricerche lungo le coste calabre dello Stretto di Messina durante l'intero anno 2008, dal limite di marea fino ad una profondità di circa 50 m, hanno portato al ritrovamento di nove specie di molluschi alieni, tutti di ambiente superficiale. Quattro di esse (*Haminoea cyanomarginata*, *Bursatella leachii*, *Melibe viridis* e *Brachidontes pharaonis*) erano già note per l'area investigata, sebbene sulla base di scarsi ritrovamenti. La presenza di *Syphonota geographica* nei mari italiani, recentemente confutata, è qui confermata, assieme alla segnalazione delle sue ovature. *Cerithium scabridum*, *Aplysia dactylomela*, *Pinctada radiata* e *Fulvia fragilis* rappresentano nuovi record per l'area di indagine. Di *C. scabridum* e *F. fragilis*, infine, sono riportati nuovi siti di rinvenimento al di fuori dell'area dello Stretto. Per tutte le specie trattate in questo lavoro sono riassunte le conoscenze sulla loro distribuzione mediterranea e, soprattutto, nei mari italiani. Sulla base di fonti bibliografiche e dei dati qui presentati risultano necessari diversi aggiornamenti a LA CHECKLIST DELLA FAUNA MARINA ITALIANA.

Key words

Mollusca, Alien species, Mediterranean Sea, Italy, Messina Strait area.

Introduction

The opening of the Suez Canal in 1869 has led to the colonization of the Mediterranean Sea by a large number of tropical/subtropical species that have established viable populations along the Levantine coast and then spread into the central Mediterranean Sea, in part by natural dispersal, in part by transport of larvae, juveniles or adult specimens by shipping. Also the increase in human activities, aquaculture and leisure boating, in the past century, contributed to the introduction of non-indigenous species in our seas. Natural and anthropic introduction of alien species contributes to the alteration of autochthonous communities and could disrupt the delicate equilibria between native biota and their physical and biological environments (Ruiz et al., 1997; Boudouresque & Verlaque, 2002; Gofas & Zenetos, 2003; Occhipinti-Ambrogi & Savini, 2003; Occhipinti-Ambrogi, 2007; Galil, 2007).

The presence of alien species in the Messina Strait is of great importance, as this is a unique Mediterranean area (Bianchi, 2007), with a highly rich and diversified flora and fauna. The biological peculiarities of the Messina Strait include some Atlantic relicts, such as Laminariales (Fredj & Giaccone, 1987), dense coverages

by Rhodophyceae (Giaccone, 1987) and rich populations of protected species, such as *Pinna uobilis* and *P. rudis* (Giacobbe & Leonardi, 1987). Not accidentally, the Messina Strait area is considered as a distinct area (sector 4) among the biogeographic sectors listed by Bianchi (2004) (Fig. 1).

The present work provides new data about several molluscan alien species occurring along the Calabrian shores of the Messina Strait area with an overview of the distribution of these species along the Italian coasts. New records of *Cerithium scabridum* and *Fulvia fragilis* out of the Messina Strait area are also reported.

Materials and methods

The Calabrian shores of the Messina Strait area, from Scilla to Saline Joniche and from the tide level to about 50 m of depth, were weekly investigated by snorkelling and SCUBA diving for several years by one of the authors (A.V.) in search of marine alien molluscan species. Out of these locations, thirteen sites, resulting strongly characterized by the presence of alien species (Fig. 1; Tab. 1), were investigated more in detail during 2008. Since the investigated sites have a different extent, only

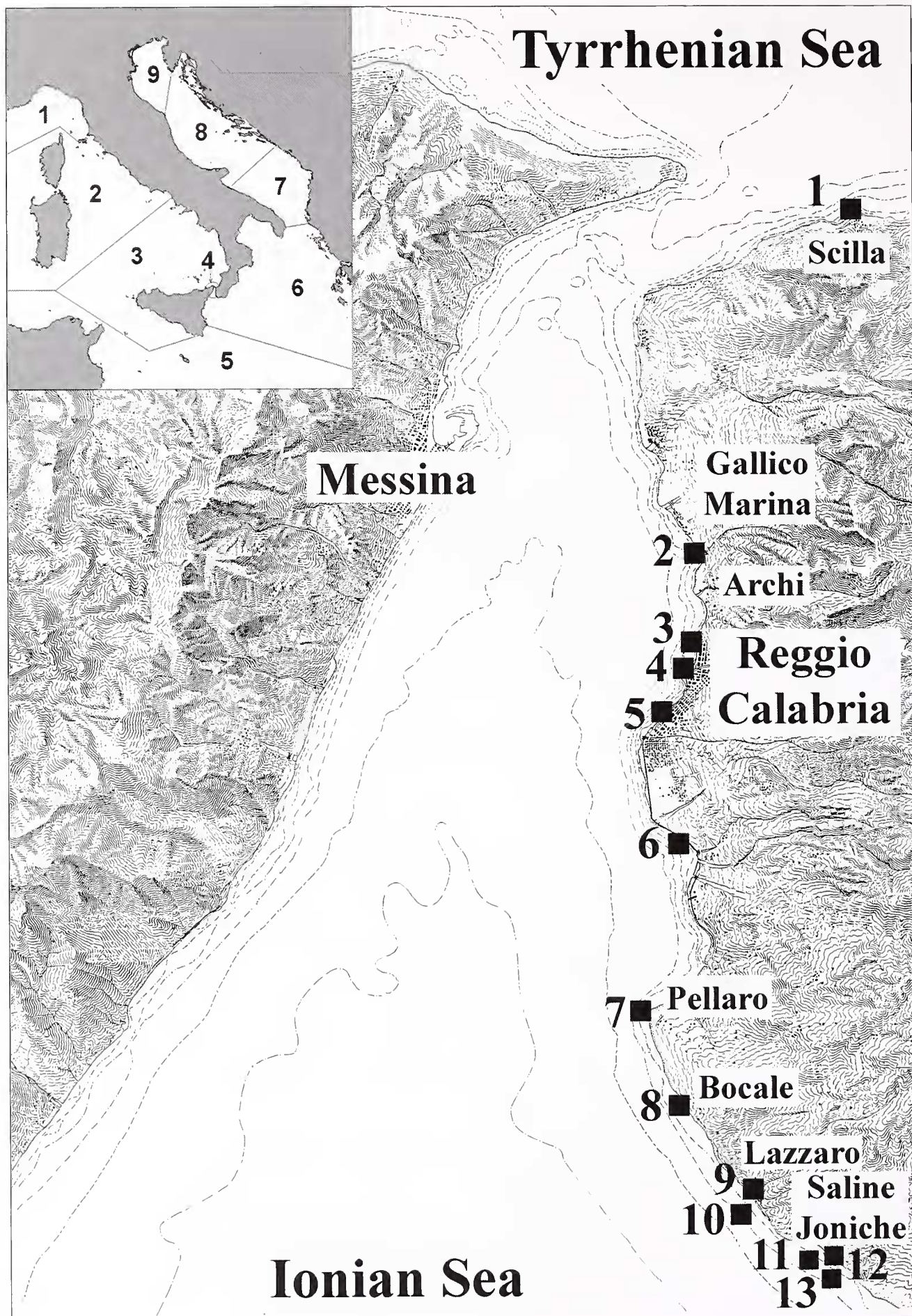


Fig. 1. Italian biogeographic sectors (after Bianchi, 2004) and sampling localities along the Calabrian shores of the Messina Strait area (sector 4).

Fig. 1. Settori biogeografici italiani (da Bianchi, 2004) e siti di campionamento lungo le coste calabre dell'area dello Stretto di Messina.

Site	Locality	Lat.	Long.	Depth (m)	Substrate/Bottom
1	Scilla	38.018313	15.633930	0-1	Artificial hard substrate
2	Gallico Marina - Archi	38.158271	15.651466	10-12	Sandy bottom with dead matte of <i>P. oceanica</i>
3	Reggio Calabria Harbour - Candeloro	38.120946	15.647182	0-2	Artificial hard substrate with <i>Corallina</i> , <i>Chaetomorpha</i> and <i>Ulva</i> species
4	Reggio Calabria Harbour - Candeloro	38.120835	15.647026	6-10	Muddy detritic bottom with sparse rocky blocks
5	Reggio Calabria Lungomare - Circolo Velico	38.109155	15.640339	6-10	Detritic sandy bottom with <i>Halophila stipulacea</i> , <i>Corallina</i> and <i>Ulva</i> species
6	Reggio Calabria Airport	38.067608	15.649521	5-6	Muddy bottom with <i>Halophila stipulacea</i>
7	Punta Pellaro	38.018313	15.633930	3	Rocky bottom with thin algal film
8	Bocale	38.002637	15.638672	3-5	Rocky bottom with algae
9	Lazzaro	37.976687	15.657593	3-5	Rocky bottom with thin algal film and <i>Cystoseira</i> sp.
10	Lazzaro	37.976119	15.656197	20	Gravel and pebbles with algae
11	Saline Joniche	37.931969	15.695751	2-6	Fish farming nets
12	Saline Joniche Harbour	37.927939	15.737320	0-2	Hard substrate with algal film
13	Saline Joniche	37.926019	15.740763	5-6	Limestone boulders with algal film and <i>Cystoseira</i> sp.

Tab. 1. Localities, geographical coordinates (N, E), depth range (m) and main characters of substrate.

Tab. 1. Località, coordinate geografiche (N, E), profondità (m) e principali caratteristiche del substrato.

semi-quantitative data and maximum densities (specimens/m²) (¥) observed are given, while a description of their living substrata and the most common macro-mollusca found in association with them are listed (Tab. 2). Whenever possible, photos of the living specimens were taken *in situ* or in aquarium (Fig. 2). Several of the observed specimens were hand-collected and are preserved dried or in 70% ethanol in the private collections of the authors and at Museo di Biologia Marina e Paleontologia di Reggio Calabria, while, when many specimens were present, only a few were taken and a numerical estimation of their abundance is given. An extensive bibliographic research on the alien recorded species was done to update their distribution along the Italian coasts. CLEMMAM – Check list of European marine mollusca (accessed on 01/2009), LA CHECKLIST DELLA FAUNA MARINA ITALIANA (2006) and the biogeographic areas defined by Bianchi (2004) are followed.

Results

Cerithium scabridum Philippi, 1848

Material

Punta Pellaro (site 7) (¥ = 1): 3 living specimens and 13 crabbed shells (Fig. 2A). Saline Joniche Harbour (site 12) (¥ = 18): 133 living specimens (Fig. 2B, C).

Gizzeria harbour (Cosenza): 79 living specimens at

10/30 cm of depth on sandy bottom, constituting the Northernmost Tyrrhenian site known for this species (Renda, pers. obs.).

Remarks

The prosobranch gastropod *Cerithium scabridum* is one of the first lessepsian species recorded in shallow waters from the Suez Canal and then in the Mediterranean from Egypt, Israel, Lebanon and Syria. Since the early 1900s it is considered as a permanent Mediterranean inhabitant. More recently it was found also in Italy, Turkey, Cyprus, Tunisia (references in Crocetta et al., 2008), Malta (Mifsud & Sammut, 2006) and Greece (Zenetos et al., 2009). Its distribution in the Italian seas was critically discussed by Crocetta et al. (2008), to which new records are added: the species lives on sandy-muddy and rocky bottoms in shallow waters on *Posidouia oceanica*, *Zostera nana* or *Cynodocea nodosa* at Siracusa (Di Natale, 1978; Piani, 1979; Di Natale, 1982; Garilli & Caruso, 2004) and Catania (Zenetos et al., 2004; Acitrezza - Crocetta & Rismondo pers. obs.), at Trapani, “La Tramontana” (Renda, pers. obs.) and San Vito Lo Capo (Garilli & Caruso, 2004), at Palermo, “Foro Umberto I” (Renda, pers. obs.), Mondello and Capo Gallo (Garilli & Caruso, 2004), and in the Otranto Harbour (Albano & Trono, 2008). A great number of dead specimens was also reported from the harbour of Vibo Valentia (Crocetta et al., 2008).

Sabelli (2006) listed *Cerithium scabridum* from sectors 3, 5 and 6, though it was not indicated as alien species. A

Species	Sites												
	1	2	3	4	5	6	7	8	9	10	11	12	13
<i>Lepidopleurus cajetanus</i> (Poli, 1791)									+				
<i>Cliton olivaceus</i> Spengler, 1797				+			+	+	+			+	
<i>Patella caerulea</i> Linné, 1758	+		+									+	
<i>Patella rustica</i> Linné, 1758	+		+										
<i>Patella ulyssiponensis</i> Gmelin, 1791	+		+										
<i>Fissurella nubecula</i> (Linné, 1758)	+		+									+	
<i>Haliotis tuberculata tuberculata</i> Linné, 1758		+		+	+		+	+	+			+	
<i>Clauculus corallinus</i> (Gmelin, 1791)				+			+	+					
<i>Jujubinus exasperatus</i> (Pennant, 1777)		+		+		+	+	+	+			+	
<i>Gibbula adansonii</i> (Payraudeau, 1826)			+										
<i>Gibbula rarilineata</i> (Michaud, 1829)	+		+				+					+	
<i>Gibbula umbilicaris</i> (Linné, 1758)		+			+		+				+		
<i>Gibbula varia</i> (Linné, 1758)			+				+	+				+	
<i>Phorcus richardi</i> (Payraudeau, 1826)	+		+										
<i>Osilinus turbinatus</i> (Born, 1778)	+		+										
<i>Calliostoma conulus</i> (Linné, 1758)		+		+			+	+		+			
<i>Calliostoma langieri</i> (Payraudeau, 1826)		+		+	+	+	+	+	+				
<i>Bolma rugosa</i> (Linné, 1767)		+			+		+	+	+				+
<i>Cerithium renovatum</i> Monterosato, 1884	+		+	+			+	+				+	
<i>Cerithium scabridum</i> Philippi, 1848							+					+	
<i>Cerithium vulgatum</i> Bruguière, 1792	+		+	+	+	+	+	+	+			+	+
<i>Bittium reticulatum</i> (da Costa, 1778)			+	+		+	+			+		+	
<i>Cirsotrema cochlea</i> (Sowerby G.B. II, 1844)		+				+							
<i>Melarhaphe neritoides</i> (Linné, 1758)	+		+										
<i>Vermetus triquetrus</i> Bivona Ant., 1832					+		+	+	+			+	+
<i>Serpulorbis arenarius</i> (Linné, 1767)					+		+	+					+
<i>Aporrhais pespelecani</i> (Linné, 1758)		+				+							
<i>Erosaria spurca</i> (Linné, 1758)					+		+	+	+				
<i>Luria lurida</i> (Linné, 1758)							+	+					
<i>Notocochlis dillwynii</i> (Payraudeau, 1826)							+	+					
<i>Tectonatica sagraiana</i> (d'Orbigny, 1842)											+		
<i>Tonna galea</i> (Linné, 1758)		+				+							
<i>Phalium granulatum</i> (Born, 1778)		+		+		+	+	+					
<i>Cymatium parthenopeum</i> (Salis, 1793)				+		+				+			
<i>Bolinus brandaris</i> (Linné, 1758)				+		+							
<i>Hexaplex trunculus</i> (Linné, 1758)		+	+	+	+	+		+	+	+		+	+
<i>Ocenebra erinaceus</i> (Linné, 1758)		+		+			+	+		+			
<i>Ocenebrina aciculata</i> (Lamarck, 1822)							+	+					
<i>Ocenebrina edwardsii</i> (Payraudeau, 1826)		+		+			+	+				+	
<i>Muricopsis cristata</i> (Brocchi, 1814)					+		+	+					
<i>Typhinellus labiatus</i> (de Cristofori & Jan, 1832)						+	+						
<i>Stramonita haemastoma</i> (Linné, 1767)				+	+		+	+	+	+		+	+
<i>Coralliophila meyendorffii</i> (Calcara, 1845)							+						
<i>Euthria cornea</i> (Linné, 1758)		+		+	+			+	+			+	
<i>Pisania striata</i> (Gmelin, 1791)				+				+	+			+	
<i>Pollia dorbignyi</i> (Payraudeau, 1826)					+		+		+				
<i>Nassarius corniculum</i> (Olivi, 1792)		+		+				+					
<i>Nassarius cuvieri</i> (Payraudeau, 1826)				+			+						
<i>Nassarius incrassatus</i> (Ström, 1768)					+		+			+			
<i>Columbella rustica</i> (Linné, 1758)	+			+	+		+	+	+				+
<i>Mitrella scripta</i> (Linné, 1758)		+		+	+							+	
<i>Fasciolaria lignaria</i> (Linné, 1758)		+		+	+		+			+			

Species	Sites												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Haminoea cyanomarginata Heller & Thompson T., 1983									+	+			+
<i>Philinopsis depicta</i> (Renier, 1807)		+				+							
Aplysia dactylomela Rang, 1828							+	+					
<i>Aplysia depilans</i> Gmelin, 1791		+		+	+	+				+			+
Syphonota geographica (Adams & Reeve, 1850)					+	+							
Bursatella leachii de Blainville, 1817		+		+		+							
<i>Notarchus punctatus</i> Philippi, 1836		+		+		+							+
<i>Petalifera petalifera</i> (Rang, 1828)									+				
Melibe viridis (Kelaart, 1858)		+		+		+							
<i>Arca noae</i> Linné, 1758				+	+		+	+				+	+
<i>Barbatia barbata</i> (Linné, 1758)				+	+		+	+	+				
<i>Glycymeris glycymeris</i> (Linné, 1758)		+				+				+			
<i>Mytilus galloprovincialis</i> Lamarck, 1819	+		+								+		
Brachidontes pharaonis (Fischer P., 1870)	+		+								+		
<i>Mytilaster</i> cfr. <i>marioni</i> (Locard, 1889)											+		
<i>Mytilaster minimus</i> (Poli, 1795)	+		+								+		
<i>Musculus costulatus</i> (Risso, 1826)											+		
<i>Modiolarca subpicta</i> (Cantraine, 1835)							+				+		
<i>Modiolus barbatus</i> (Linné, 1758)		+		+		+	+			+			+
<i>Pinna nobilis</i> Linné, 1758		+		+	+	+				+			
<i>Pinna rudis</i> Linné, 1758				+			+			+			
Pinctada radiata (Leach, 1814)						+	+	+	+	+	+	+	
<i>Pecten jacobaeus</i> (Linné, 1758)		+			+	+				+			
<i>Crassadoma multistriata</i> (Poli, 1795)				+			+	+					
<i>Chlamys varia</i> (Linné, 1758)		+		+			+		+				+
<i>Spondylus gaederopus</i> Linné, 1758				+			+	+	+				+
<i>Anomia ephippium</i> Linné, 1758				+	+		+		+		+		+
<i>Pododesmus patelliformis</i> (Linné, 1761)				+				+					
<i>Limaria hians</i> (Gmelin, 1791)		+		+	+		+						
<i>Ostreola stentina</i> (Payraudeau, 1826)				+			+				+		+
<i>Chama gryphoides</i> Linné, 1758				+	+		+	+	+			+	+
<i>Pseudochama gryphina</i> (Lamarck, 1819)					+	+	+		+				+
<i>Acanthocardia aculeata</i> (Linné, 1758)		+				+				+			
<i>Acanthocardia tuberculata</i> (Linné, 1758)		+		+		+							
<i>Parvicardium exiguum</i> (Gmelin, 1791)		+		+	+	+	+	+		+		+	+
<i>Papillicardium papillosum</i> (Poli, 1791)		+				+	+			+			
<i>Laevicardium crassum</i> (Gmelin, 1791)		+		+		+				+			+
Fulvia fragilis (Forskål, 1775)						+							
<i>Mactra glauca</i> Born, 1778						+							
<i>Tellina incarnata</i> Linné, 1758		+				+							
<i>Tellina planata</i> Linné, 1758		+		+		+							
<i>Arcopagia balaustina</i> (Linné, 1758)						+				+			
<i>Gari depressa</i> (Pennant, 1777)		+		+		+				+			+
<i>Venus verrucosa</i> Linné, 1758		+		+			+	+		+			
<i>Chamelea gallina</i> (Linné, 1758)		+				+				+			+
<i>Callista chione</i> (Linné, 1758)		+				+				+			
<i>Venerupis aurea</i> (Gmelin, 1791)		+				+							
<i>Thracia corbuloides</i> Deshayes, 1830		+		+		+				+			
<i>Pandora inaequalis</i> (Linné, 1758)				+		+							

Tab. 2. Alien species (in bold) and the most common macro-molluscs found in association with them. Sites correspond to localities listed in Tab. 1.

Tab. 2. Specie aliene (in grassetto) e macro-molluschi più comuni rinvenuti in associazione con esse. I siti corrispondono alle località riportate nella Tab. 1.



record between sectors 6 and 7 was also recently reported (Albano & Trono, 2008). It is here recorded from sector 4.

Haminoea cyanomarginata
Heller & Thompson, 1983

Material

Lazzaro (site 9) (Y = 16): about 150 (estimate) living specimens. Lazzaro (site 10) (Y = 5): 57 living specimens (Fig. 2D, E). Saline Joniche (site 13) (Y = 20): about 200 (estimate) living specimens.

Remarks

Haminoea cyanomarginata is a cephalaspidean mollusc considered one of the recent lessepsian immigrants, although there are no records from the easternmost Mediterranean. It was first recorded from the Mediterranean Sea in November 2001, when 31 live specimens were found at Porto Germeno (Gulf of Corinth, Greece) (Zenetos et al., 2004; Zenetos et al., 2005; Mollo et al., 2008). Then, *H. cyanomarginata* was found in Turkey in 2002 (Yokes & Rudman, 2004) and in Malta in 2006 (Mifsud, 2007). One year later (September 2007) about 70 live specimens were found at Saline Joniche (Reggio Calabria), at a depth of about 6 m on calcareous boulders covered by a thin algal film and colonized by *Cystoseira* sp. (Crocetta & Vazzana, 2008).

Egg-masses of *H. cyanomarginata* were observed on *Cystoseira* by Crocetta & Vazzana (2008) for the first time in the Mediterranean Sea. In the present survey it was often observed in couple, showing a trailing behaviour.

Haminoea cyanomarginata is one of the latest aliens in the Italian waters, not yet present in LA CHECKLIST DELLA FAUNA MARINA ITALIANA (Cattaneo-Vietti, 2006).

Aplysia dactylomela Rang, 1828

Material

Punta Pellaro (site 7) (Y = 1): 1 living specimen. Bocale (site 8) (Y = 2): 3 living specimens (Fig. 2F, G).

Remarks

Aplysia dactylomela is an opisthobranch mollusc with a worldwide distribution in tropical and warm-temperate

waters of the Atlantic (d'Orbigny, 1839; Wirtz, 1998; Wirtz, 1999; Ortea et al., 2001) and Indo-Pacific, including Red Sea (Marcus & Marcus, 1967; Bebbington, 1974; Dekker & Orlin, 2000; Burn, 2006).

In the latest years this species has been reported from the Mediterranean. A first live specimen was reported from Lampedusa Island (Trainito, 2003; Trainito, 2005). The specimen was found at Guitcia, on April 2002, at 3 m of depth, on a sandy-rocky bottom with *Caulerpa racemosa* (Trainito, pers. comm.). *A. dactylomela* was then recorded from Greece in 2005 (Zenetos et al., 2007), Turkey in 2006 (Çinar et al., 2006a; Yokes, 2006) and Malta (Schembri, 2008), while several records from Cyprus and Croatia appeared on the www.seaslugforum.net website. Its distribution and expansion trend in the Italian seas were recently summarized by Crocetta & Colamonaco (2008): the species is locally common along the eastern Sicilian shores from Messina to Syracuse, with a single record from Gallipoli (Puglia).

Aplysia dactylomela is listed for sectors 5 and 6 (Cattaneo-Vietti, 2006) and should be added to the species list of sector 4 (present paper).

Syphonota geographica (Adams & Reeve, 1850)

Material

Reggio Calabria Lungomare - Circolo Velico (site 5) (Y = 2): 4 living specimens. Reggio Calabria - Airport (site 6) (Y = 1): 2 living specimens (Fig. 2H, I).

Remarks

Syphonota geographica is an anaspidean mollusc recently recorded from Greece (Mollo et al., 2008) and Turkey (Yokes & Rudman, 2004). The species first appeared in a photo from the Mediterranean Sea in Turano & Neto (2001), identified as *Phyllaplysia lafonti*, then in Costa et al. (2002) as *Petalifera petalifera*. A few years ago, Scuderi & Russo (2005) correctly identified it as *Syphonota geographica* from the illustration in Costa et al. (2002) and generically reported it from the Sicilian shores of the Messina Strait. No additional data were then known by the two authors (Scuderi, pers. comm.).

The specimens illustrated by Turano & Neto (2001) and Costa et al. (2002) were from Reggio Calabria, where this species is present, though rare, since 1999. Egg-masses were always noted in September (Neto, pers.

Fig. 2. Alien Mollusca from the Calabrian shores of the Messina Strait area (not to scale). **A-C.** *Cerithium scabridum*. **A.** Punta Pellaro (site 7), 13 × 6 mm; **B, C.** Porto di Saline Joniche (site 12), 16 × 8 mm, 17 × 8 mm. **D, E.** *Haminoea cyanomarginata*, Lazzaro (site 10). **D.** Living specimen, 18 × 8 mm; **E.** Its shell, 8 × 6 mm. **F, G.** *Aplysia dactylomela*, Bocale (site 8). **F.** Living specimen, 130 mm. **G.** Its shell, 40 × 32 mm. **H, I.** *Syphonota geographica*, Reggio Calabria Airport (site 6). **H.** Living specimen, 120 mm; **I.** Its shell, 40 × 29 mm. **L.** *Bursatella leachii*, Reggio Calabria Airport (site 6), 150 mm. **M.** *Melibe viridis*, Reggio Calabria Airport (site 6), 180 mm. **N.** *Brachidontes pharaonis*, Saline Joniche (site 11), 31 × 14 mm. **O-Q.** *Pinctada radiata*. **O, Q.** Saline Joniche (site 11), 31 × 34 mm, 36 × 39 mm; **P.** Reggio Calabria Airport (site 6), 44 × 49 mm. **R.** *Fulvia fragilis*, Reggio Calabria Airport (site 6), 38 × 34 mm.

Fig. 2. Molluschi alieni dalle coste calabre dell'area dello Stretto di Messina (non in scala). **A-C.** *Cerithium scabridum*. **A.** Punta Pellaro (sito 7), 13 × 6 mm; **B, C.** Porto di Saline Joniche (sito 12), 16 × 8 mm, 17 × 8 mm. **D, E.** *Haminoea cyanomarginata*, Lazzaro (sito 10). **D.** Esemplare vivente, 18 × 8 mm. **E.** La sua conchiglia, 8 × 6 mm. **F, G.** *Aplysia dactylomela*, Bocale (sito 8). **F.** Esemplare vivente, 130 mm. **G.** La sua conchiglia, 40 × 32 mm. **H, I.** *Syphonota geographica*, Aeroporto di Reggio Calabria (sito 6). **H.** Esemplare vivente, 120 mm. **I.** La sua conchiglia, 40 × 29 mm. **L.** *Bursatella leachii*, Aeroporto di Reggio Calabria (sito 6), 150 mm. **M.** *Melibe viridis*, Aeroporto di Reggio Calabria (sito 6), 180 mm. **N.** *Brachidontes pharaonis*, Saline Joniche (sito 11), 31 × 14 mm. **O-Q.** *Pinctada radiata*. **O, Q.** Saline Joniche (sito 11), 31 × 34 mm, 36 × 39 mm. **P.** Aeroporto di Reggio Calabria (sito 6), 44 × 49 mm. **R.** *Fulvia fragilis*, Aeroporto di Reggio Calabria (sito 6), 38 × 34 mm.

comm.). Recently, many good photos of *Syphonota geographica* were published by Neto (2006) and a probable attempt of predation by *Astropecten aranciacus* (Linné, 1758) was reported by Guerrieri & Neto (2007), again from Reggio Calabria (Neto, pers. comm.).

Syphonota geographica should be included in LA CHECK-LIST DELLA FAUNA MARINA ITALIANA (Cattaneo-Vietti, 2006) for sector 4.

Bursatella leachii de Blainville, 1817

Material

Archi-Gallico (site 2) (¥ = 2): 14 living specimens. Reggio Calabria Harbour-Candeloro (site 4) (¥ = 2): 27 living specimens. Reggio Calabria Airport (site 6) (¥ = 3): about 50 (estimate) living specimens (Fig. 2L).

Remarks

Bursatella leachii is an anaspidean mollusc with circum-tropical diffusion (Eales & Engel, 1935). The first Mediterranean record probably is the one by O'Donoghue & White (1940), although no locality was added to the preserved specimen. After the first record, the species rapidly spread along the coasts of Israel (Eales, 1970; Barash & Danin, 1971; Barash & Zenziper, 1980), Turkey (Swennen, 1961; Kazak & Cavas, 2007), Malta (Bebbington, 1970; Sciberras & Schembri, 2007; Goud & Mifsud, 2009), Tunisia (Enzenroß & Enzenroß, 2001; Ben Souissi et al., 2003), Croatia (Jaklin & Vio, 1989), Greece (Barash & Danin 1986; Daskos & Zenetos, 2007), Lebanon (Zenetos et al., 2004), Spain (Oliver & Terrasa, 2004) and Italy, where several specimens were reported from Mar Piccolo and Mar Grande (Taranto) between 1968 and 1973 (Tortorici & Panetta, 1977). *B. leachii* was not reported by Vatova (1975) from samplings carried out in 1966-1969 in the Gulf of Taranto, so the species most probably appeared in the Italian seas in the early 1970's. After this first record the species spread rapidly along the Italian seas and was reported from the following biogeographic areas:

sector 1: Fortullino (Piani in Icrum, 2006; Scotti pers. comm.);

sector 2: Gulf of Cagliari (Zenetos et al., 2004; Olita, 2006), present since 1995 - hundreds of specimens beached at Poetto (Piras, pers. obs.);

sector 3: Palermo area (Parrinello & Catalano, 1978; Catalano et al., 1978); Campanian shores (Fasulo et al., 1984; Russo, 1985; Jaklin & Vio, 1989; Zupo et al., 1990; Lorenti et al., 2008);

sector 4: Neto, 2003 (photos taken along Reggio Calabria shores, from Archi to Pellaro - Neto, pers. comm.), present since 1990 along the Calabrian shores of the Strait area (Vazzana, pers. obs.);

between sector 5 and 6: S. Panagia Bay (Syracuse) (Piani, 1980);

sector 6: Gulf of Taranto and neighbouring areas (Panetta, 1976; Panetta, 1977; Tortorici & Panetta, 1977; Palazzi & Boccolini, 1980; Panetta, 1981; Tursi et al., 1981; Bello,

1982; Perrone, 1983; Fasulo et al., 1984; Russo, 1985; Carrioglio et al., 2004) - eastern Sicilian shores (Russo, 1985; Scotti et al., 2006 in Icrum, 2006; Scotti, pers. comm.);

sector 7: Bari (Vaccarella & Pastorelli, 1983; Vaccarella, 1986);

between sector 7 and 8: Margherita di Savoia (Foggia) (Vaccarella, 1986);

sector 9: Gulf of Trieste (Jaklin & Vio, 1989; Vio & De Min, 1996; De Min & Vio, 1998; Vio & De Min, 1999) - Venice area (Cesari et al., 1986; Cesari, 1994; Mizzan, 1999; Mizzan & Vianello, 2009) - Emilia Romagna (Rinaldi, 2007; 2008).

Bursatella leachii lives on muddy, sandy and muddy/sandy bottoms with *Caulerpa prolifera* or *Cymodocea nodosa* and *Zostera noltii* (Zenetos et al., 2004).

Cattaneo-Vietti (2006) listed *Bursatella leachii* from sectors 2 to 6 and 9. Recent records from the Gulf of Trieste (Poloniato & Balasso, pers. obs.) and northern Adriatic shores (Rinaldi, 2007; 2008; Mizzan & Vianello, 2009) suggest that the species is still present in the area, although only genetic analysis could confirm if they are related to the first introduction or represent a subsequent introduction. The species should be listed for all the Italian biogeographic areas.

Melibe viridis (Kelaart, 1858)

Material

Archi-Gallico (site 2) (¥ = 2): 14 living specimens. Reggio Calabria Harbour-Candeloro (site 4) (¥ = 2): 17 living specimens. Reggio Calabria Airport (site 6) (¥ = 3): about 50 (estimate) living specimens (Fig. 2M).

Remarks

Melibe viridis is a large nudibranch with a wide distribution in the Indo-Pacific areas (Gosliner & Smith, 2003) first recorded in the Mediterranean Sea from Greece as *Melibe fimbriata* (Thompson & Crampton, 1984). Later on the species was reported again from Greece (Moosleitner, 1986; Koutsoubas & Cinelli, 1997), Tunisia (Cattaneo-Vietti et al., 1990), Croatia (Despalatovic et al., 2002), Turkey (Yokes & Rudman, 2004) and Malta (Borg et al., 2009), while several photos of specimens from Montenegro and Cyprus appeared on www.seaslugforum.net website. About ten years ago it was also found along the Calabrian shores of the Strait area (Mojetta, 1998), where in September 1997 (Neto, pers. comm.) several specimens were found from 5 to 15 m of depth on a soft bottom with *Cymodocea nodosa* (Ucria) Ascherson and *Halophila stipulacea* (Forskål) Ascherson. Thus, *M. viridis* did not arrive in the Italian seas in 1984, as reported by Mastrototaro et al. (1984), who misunderstood a statement in Mojetta (1998), while the species is present along the southern Calabrian shores since 1991 (Vazzana, pers. obs.). Then *M. viridis* spread along the Sicilian shores, where 8 specimens were recorded in the neighbourhood of Catania (Pozzillo, Acitrezza, Capo Molini) on rocky bottoms at 2-3 m of depth (Scuderi &

Russo, 2003) and along the Calabrian shores of the Ionian Sea (record from Capo Bianco by Villani, pers. comm. in Zenetos et al., 2004), early followed by two records from the Gulf of Taranto. Several specimens (and spawning) were recorded from muddy bottom with *Cladophora prolifera* down to 30 m in depth at Porto Cesareo (Lecce) and on a muddy bottom with *Caulerpa prolifera* turf down to 10 m depth in Mar Grande of Taranto (Mastrototaro et al., 2004). More than 50 specimens were observed in Mar Piccolo and Mar Grande of Taranto on muddy bottoms covered with dense algal beds or near mussel farms (Carriglio et al., 2004). More recently, several specimens were found in *Cymodocea nodosa* meadows at 6 m of depth in the roadstead of Golfo Aranci (Doneddu & Trainito, 2008).

Melibe viridis is listed for sectors 6 and 7 (Cattaneo-Vietti, 2006). Records from sector 7 are not located along the Italian shores. It should be also listed for sectors 2 (Doneddu & Trainito, 2008) and 4 (Mojetta, 1998; present work).

Brachidontes pharaonis (Fischer P., 1870)

Material

Scilla (site 1) (Y = 2): 7 living specimens and 8 shells. Reggio Calabria Harbour - Candeloro (site 3) (Y = 5): 29 living specimens. Saline Joniche (site 11) (Y = 12): more than 200 (estimate) living specimens (Fig. 2N).

Remarks

Brachidontes pharaonis is one of the first lessepsian entries, first recorded in the Mediterranean Sea only seven years after the opening of the Suez Canal (Fuchs, 1878). After this record, the species rapidly spread all through the Eastern Basin (Gravel and Moazzo, 1931; Haas, 1937; Barash & Danin, 1986; Rilov et al., 2004) and towards the central sectors in Greek, Cypriot and Turkish waters (Kinzelbach, 1985; Tenekides, 1989; Cecalupo & Quadri, 1996; Buzzurro & Greppi, 1996; Buzzurro & Greppi, 1997; Doğan et al., 2007). It was also recorded from Malta (Cachia et al., 2004), even though its presence in the Maltese waters was questioned by Sciberras & Schembri (2007), and from Corsica (Merella et al., 1994; Boudouresque, 1999). A single record is from Croatia (Vio & De Min, 1996; De Min & Vio, 1998; Vio & De Min, 1999), where the species has been never recorded again (Vio, pers. comm.). Further researches seem to confirm that *B. pharaonis* did not survive in this area (Crocetta, pers. obs.).

It was first reported in 1969 from the Italian seas, along the northern and southern shores of Syracuse, where the species was sampled from the tide level to 2 m of depth, byssed on rocky bottom or on shell grit in a polluted area near the Augusta Harbour, probably ship-transported (Di Geronimo, 1971a; 1971b). In the following year the species rapidly spread all through the Catania Gulf and was also recorded from Milazzo (Arcidicono & Di Geronimo, 1976), eastern Sicily and several

other Sicilian sites (Di Natale, 1982; Gianguzza et al., 1997; Gianguzza et al., 1998a; Gianguzza et al., 1998b; Gianguzza et al., 2001; Russo et al., 2004; Sirna Terranova et al., 2006), where it is locally abundant, sometimes forming dense populations with over 25,000 specimens/m² (Sarà et al., 2006). The species was recorded from the Calabrian shores, at Le Castella (Crotone), on the Ionian coasts (Zanca, 1976), and at Scilla and Vibo Valentia Marina, on the Tyrrhenian coasts (Di Natale, 1982; Crocetta et al., 2008).

Brachidontes pharaonis is listed for sectors 2, 4, 5 and 9 (Schiaparelli, 2006), although records from sectors 2 and 9 are not located along the Italian shores. The species should be also listed for sector 6 (Zanca, 1976; Russo et al., 2004) and excluded from sector 9 (present work).

Pinctada radiata (Leach, 1814)

Material

Reggio Calabria Airport (site 6) (Y = 1): 10 living specimens (Fig. 2P). Punta Pellaro (site 7) (Y = 3): about 30 (estimate) living specimens. Bocale (site 8) (Y = 1): 4 living specimens. Lazzaro (site 9) (Y = 1): 6 living specimens. Lazzaro (site 10) (Y = 2): 2 living specimens. Saline Joniche Harbour (site 12) (Y = 1): 8 living specimens. Saline Joniche (site 11) (Y = 15): about 300 (estimate) living specimens (Fig. 2O-Q).

Remarks

Pinctada radiata is among the first alien molluscs recorded from the Mediterranean Sea and its sudden and wide propagation is still puzzling. In a few years after the opening of the Suez Canal, it colonized the whole Eastern Mediterranean with some localities in the central areas too, probably due both to natural dispersal and human transport (Zenetos et al., 2004). The first specimen (66 mm in maximum diameter) recorded from the Italian shores, at Lampedusa Island, was misidentified as *Margaritana margaritifera* by Parenzan (1961). In the following years, several papers confirmed the presence of this species at Lampedusa: five living specimens were reported from 40 m of depth on a detritic and detritic-muddy bottom byssed on *Arca noae*, barnacles and on conspecific specimens (Bombace, 1966, 1967), two live specimens were reported byssed on *Cystoseira* sp. at 50 cm of depth respectively from Cala Croce and Guitcia (Paccagnella, 1967; Bombace, 1967), several live, dead specimens and loose valves were reported from various localities at Lampedusa (Spada, 1969; Spada et al., 1973), five live specimens and several valves at 25 m of depth (Di Natale, 1982) and three juveniles as epibiont on a carapace of a loggerhead sea turtle *Caretta caretta* (Oliverio et al., 1992). Living and dead specimens of *P. radiata* were also reported from Pantelleria Island (Garavelli & Melone, 1967a; Sabelli, 1969), Syracuse (Paccagnella, 1967; Bombace, 1967; Gaglini, 1994), and Palermo (Bombace, 1967; Ricordi, 1993). Di Natale (1982) reported also 3 live specimens and loose valves

at 40-45 m of depth at Lipari and one living specimen at 3 m of depth from Acitrezza and Di Geronimo (1971) reported it from the Catania Harbour.

This alien species is considered as "frequent" along the whole Sicilian shores by Zenetos et al. (2004). Regarding Italian distribution, out of the Sicilian shores, dead complete specimens were found at 7 m of depth on a rocky bottom covered by algae at Alassio (Isola Gallinara, Liguria) (Garavelli & Melone, 1967b) and on an oil platform from the Sicily Channel in reparation in Trieste (North Adriatic) (Vio & De Min, 1996; De Min & Vio, 1998; Vio & De Min, 1999). In the Gulf of Trieste the species has been never recorded again (Vio, pers. comm.) and further researches in the area seem to confirm that it did not survive (Crocetta, pers. obs.). However, recently, two juvenile specimens (less than 3 mm in shell length) from 59 m in the Croatian waters were identified as *Pinctada radiata* by Doğan & Nerlović (2008). This record is probably not related with the previous finding in the Gulf of Trieste (Vio & Min, 1996).

Pinctada radiata is listed for sectors 3, 4, 5 and 9 (Schiaparelli, 2006). The species should be added to sector 6 (Di Geronimo, 1971) and excluded from sector 9 (present paper). The record from sector 1 (Garavelli & Melone, 1967b) was not confirmed by living specimens, while no data are known from a record in sector 2, not located along the Italian shores (Boudouresque, 1999).

Fulvia fragilis (Forskål, 1775)

Material

Reggio Calabria Airport (site 6) (Y = 1): one living and one dead specimen (Fig. 2R).

Syracuse, La Plaia, mouth of the Anapo River: 30 living specimens beached or at 5-10 m of depth on sandy bottom (Crocetta & Rismondo, pers. obs.), present at least since 2007 (Corso, 2007).

Remarks

Fulvia fragilis (Forskål, 1775) was first recorded from Port Said (Moazzo, 1939) and in 1955 from Israel (Haifa Bay), where 3 specimens were found on gravel at 30 m (Barash & Danin, 1972). Its common occurrence along the Israelian coasts was confirmed by Ghisotti (1974) and Barash & Danin (1977). Then it rapidly spread through the whole Mediterranean Sea: records are from Turkey (Lindner, 1988; Enzenross et al., 1990; Niederhöfer et al., 1991; Engl, 1995; Buzzurro & Greppi, 1996; Öztürk & Poutiers, 2005; Çinar et al., 2006b), Tunisia (Passamonti, 1996) (Enzenroß & Enzenroß, 2001) (Ben Souissi et al., 2003), Greece (Vardala-Theodorou, 1999; Zenetos et al., 2005; Zenetos et al., 2007), Spain (Zenetos et al., 2004; Goud & Mifsud, 2009) and Malta (Goud & Mifsud, 2009).

More recently *Fulvia fragilis* was recorded from the Italian seas too, at Calambrone (Livorno), Castellaneta Marina (Taranto) and in several stations in the Gulf of Naples, from sea level to about 15 m, on sandy and muddy

bottoms (Crocetta, 2005; Crocetta et al., 2008). It is found from a few meters to about 40 m on sandy, muddy and sandy-muddy bottoms, sometimes associated to phanerogams (Zenetos et al., 2004).

Fulvia fragilis is listed for sectors 2 and 3 (Schiaparelli, 2006). There are no records from sector 2, while the one from Calambrone (Crocetta, 2005) is located in sector 1. Although its presence in sector 3 is confirmed by the finding of several live and dead specimens (Crocetta et al., 2008), the record from sector 1 needs confirmation with living specimens. The species should be then listed for sectors 6 (Crocetta et al., 2008, present paper) and 4 (present work).

Discussion

Because of its central position in the Mediterranean, the Messina Strait area can be considered as an important ecological area for the settlement of the lessepsian species, when spreading from the Eastern to the Western Basin. It is worth remarking that it hosts other alien species of different groups (Golani et al., 2002; Galil et al., 2002), in addition to 9 shallow water molluscan species as herein reported.

Six molluscan species (*Cerithium scabridum*, *Haminoea cyanomarginata*, *Bursatella leachii*, *Brachidontes pharaonis*, *Pinctada radiata* and *Fulvia fragilis*) are surely of Indo-Pacific origin. They entered via the Suez Canal, though their progressive distribution in the Mediterranean Sea may be due to human transport (shipping, aquaculture). Regarding the three remaining species, different ways of introductions can be hypothesized.

The status of *Aplysia dactylomela* is unclear, since viable populations exist both in the Red Sea and in the Atlantic Ocean, but its Mediterranean distribution is limited to the eastern and central sectors, without records from the Western Mediterranean. Its introduction, however, could be due to human transport too, as proposed by Scuderi & Russo (2005). *Melibe viridis*, on the contrary, was listed as a lessepsian migrant by Cattaneo-Vietti (2006), but no records are known from the Red Sea (Dekker & Orlin, 2000), as also reported by Doneddu & Trainito (2008). *Syphouota geographica* has been recorded along the Italian shores since 1999, so its first Mediterranean record is situated in the investigated areas.

Haminoea cyanomarginata, *Bursatella leachii*, *Melibe viridis* and *Brachidontes pharaonis* were still known from the investigated area and the presence of three of them after several years from the last record bring evidences of their stability in the Messina Strait.

Bursatella leachii and *Melibe viridis* can be considered a definitively resident species in the opisthobranch fauna of the Messina Strait and the date of their first record along the investigated shores is also backdated. Both species were found together in three of the thirteen sites of investigations, with remarkable abundance in site 6 (Reggio Calabria Harbour). Their co-occurrence on vegetated soft bottoms was also documented by Carriglio et al. (2004) from the Gulf of Taranto.

Brachidontes plaraonis, on the contrary, was reported long time ago from a single site (Scilla) on the Calabrian shores of the Messina Strait (Di Natale, 1982). This species is herein recorded from two new sites. The dense populations known from Sicily are not present along the Calabrian shores, and in none of the investigated sites *Brachidontes plaraonis* forms monospecific clusters, sharing its life space mainly with *Mytilaster minimus* or with *Mytilus galloprovincialis*.

Haminoea cyanomarginata was until now only known from a single site (Crocetta & Vazzana, 2008: site 13 in the present work) and is here reported from two additional nearby localities. The species is stable in the area between Lazzaro and Saline Joniche and new records could be expected from the Eastern Sicilian shores and the Ionian Sea.

Syphonota geographica is definitively confirmed in the Italian seas, while *Cerithium scabridum*, *Aplysia dactylomela*, *Pinctada radiata* and *Fulvia fragilis* are new from the area.

The presence of *Syphonota geographica* is documented for Greece (Mollo et al., 2008) and Turkey (Yokes & Rudman, 2004), while its presence along the Italian shores was recently rejected (Cattaneo-Vietti, 2006). This species actually occurs as stable populations along the Italian shores from 1999 to 2005 (Neto, pers. obs.) and from 2007 to 2008 (present work), as also confirmed by the findings of egg-masses. In the investigated area, *Syphonota geographica* was only found in sites 5 and 6, where it is closely associated with *Halophila stipulacea*, as also observed by Mollo et al. (2008). Its presence along the Sicilian shores of the Messina Strait is highly probable, but it needs a confirmation. *Halophila stipulacea* was recently recorded from Salerno, Campania (Gambi et al., 2008), and this could be an interesting study area for the possible occurrence of *S. geographica*.

The presence of *Cerithium scabridum* and *Pinctada radiata* in the area is not surprising, as the species are widely present in the eastern Sicily. Considering the high probable presence of a population of *Cerithium scabridum* situated in Vibo Valentia Harbour (Crocetta et al., 2008), our records from Saline Joniche Harbour (site 12) and Gizzeria harbour (Cosenza) suggest that the species is forming new populations along the Tyrrhenian Calabrian shores, mainly in the vicinity of or inside touristic harbours, following the pattern of secondary spread of already established species reported by Savini et al. (2006a; 2006b). It is worth remarking that also the recent record from the southern Apulia (Albano & Trono, 2008) is from an harbour area.

Pinctada radiata is one of the first alien Mediterranean species, so its common presence from Reggio Calabria to Saline Joniche, as well as the finding of a very high number of adult and juveniles specimens in site 11, can be considered normal. Its impact along the Calabrian shores of the Messina Strait has to be backdated to 1995, when a high number of specimens were noted from Lazzaro to Capo dell'Armi (Vazzana, pers. obs.). Even though the species is highly polymorphic in external and internal shell characters and remarkable differences

can be noted between adults and juveniles, we think that all the specimens found in the investigated area are *Pinctada radiata*. A closely similar species, *Pinctada margaritifera*, is reported in LA CHECKLIST DELLA FAUNA MARINA ITALIANA (Schiaparelli, 2006) following Zenetos et al. (2004), but not in the older Italian checklist (www.faunaitalia.it) and in CLEMAM. It was added in the new check-list according to a project, described by Bellet (1899), about the introduction of 10,000 specimens of *P. margaritifera* in the area of Bova Marina (southern Calabria), but there are no traces of its realization. Further, no species of *Pinctada* was reported before the early 1960's from the Italian seas. It is worth remarking that *P. margaritifera* is a macro-species, which can live also in very shallow waters: its occurrence in the Italian seas since the beginning of the XX century would have been easily noted. Thus, *Pinctada margaritifera* should be excluded from the list of species living in the Italian waters.

The last two species recorded in the investigated area are two of the last Italian alien arrivals: *Aplysia dactylomela* and *Fulvia fragilis*.

Aplysia dactylomela is locally common along the Sicilian shores of the Messina Strait (Crocetta & Colamonaco, 2008). The finding of 4 specimens along the Calabrian shores may suggest that the species is trying to form new and stable populations, as proposed by Oliverio & Chemello (1996). Thus, it can be expected that in the next years the species will colonize the southern Tyrrhenian Sea. Similar considerations can be commented for *Fulvia fragilis*, so far known only from the peninsular Tyrrhenian shores and Gulf of Taranto. The finding of two specimens (one of which living) in the investigated area points to an ongoing diffusion due to natural dispersal, as large populations of this species are present at Syracuse, La Plaia (Crocetta & Rismondo, pers. obs.) and in Malta (Goud & Mifsud, 2009).

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